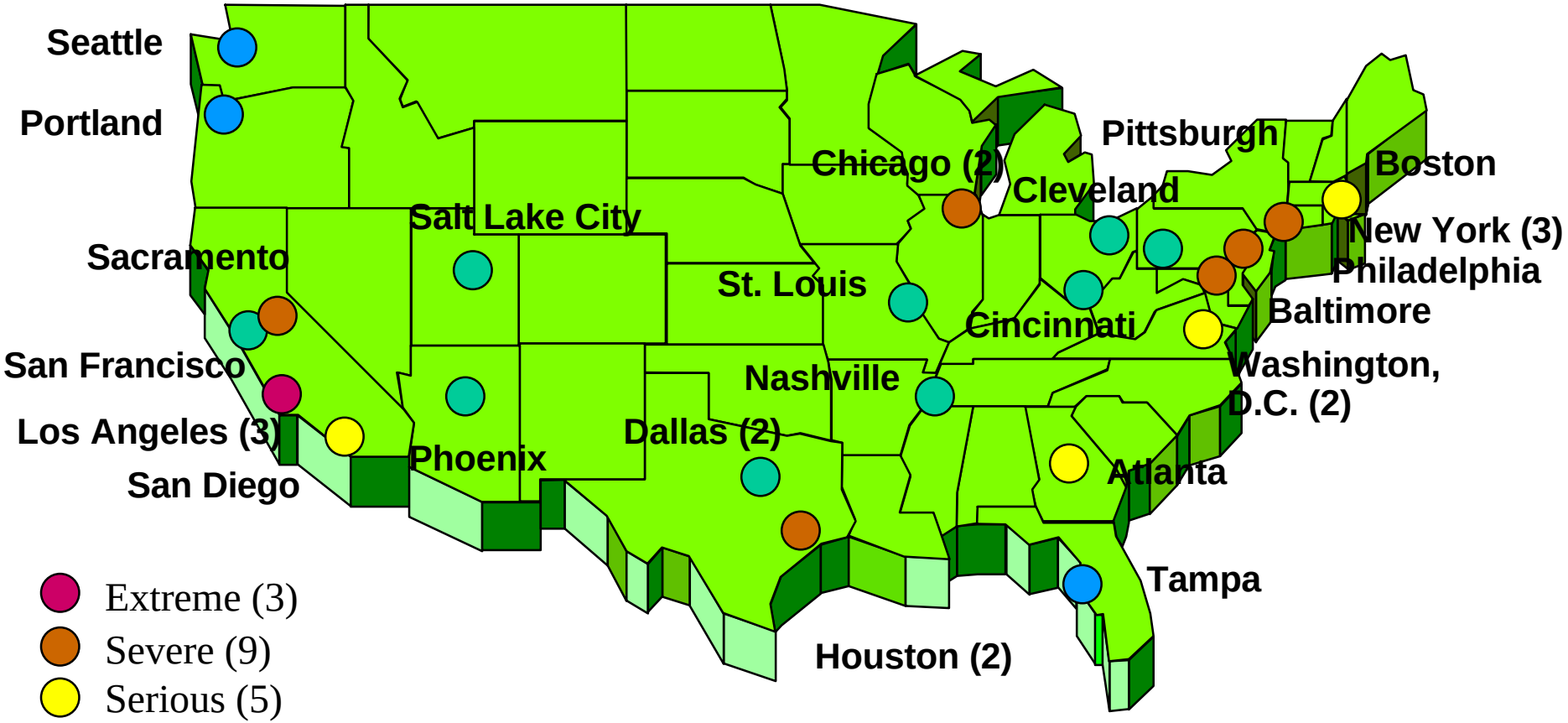
CAA Non-Attainment

Paul Helliker

- Currently 164 air quality non-attainment areas in U.S.
- 121 million people reside in these non-attainment areas
- New ozone and particulate matter standards will expand non-attainment areas
- 29 of the 50 busiest airports in the U.S. are in existing non-attainment areas

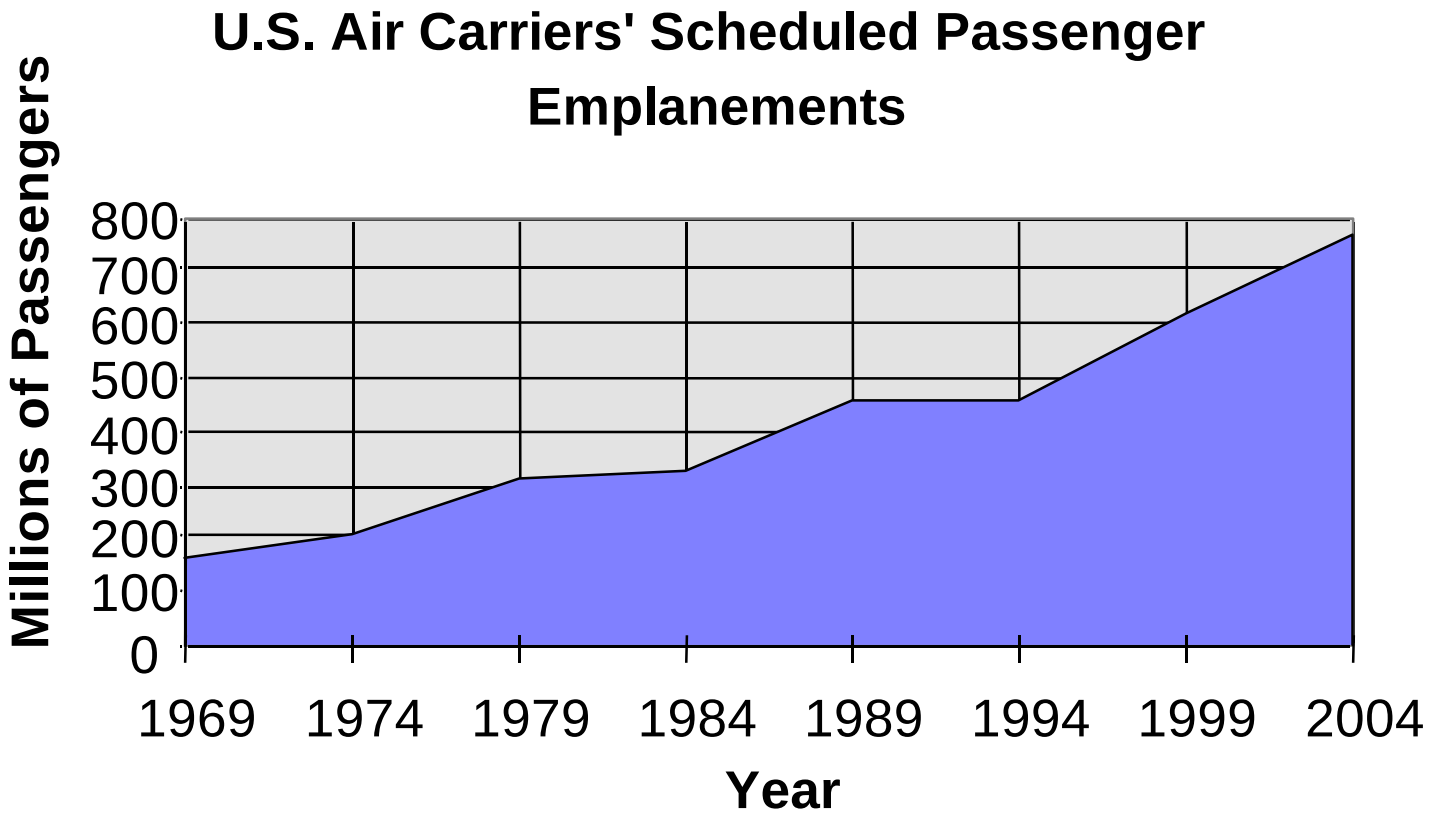
Airports and Ozone

Paul Helliker



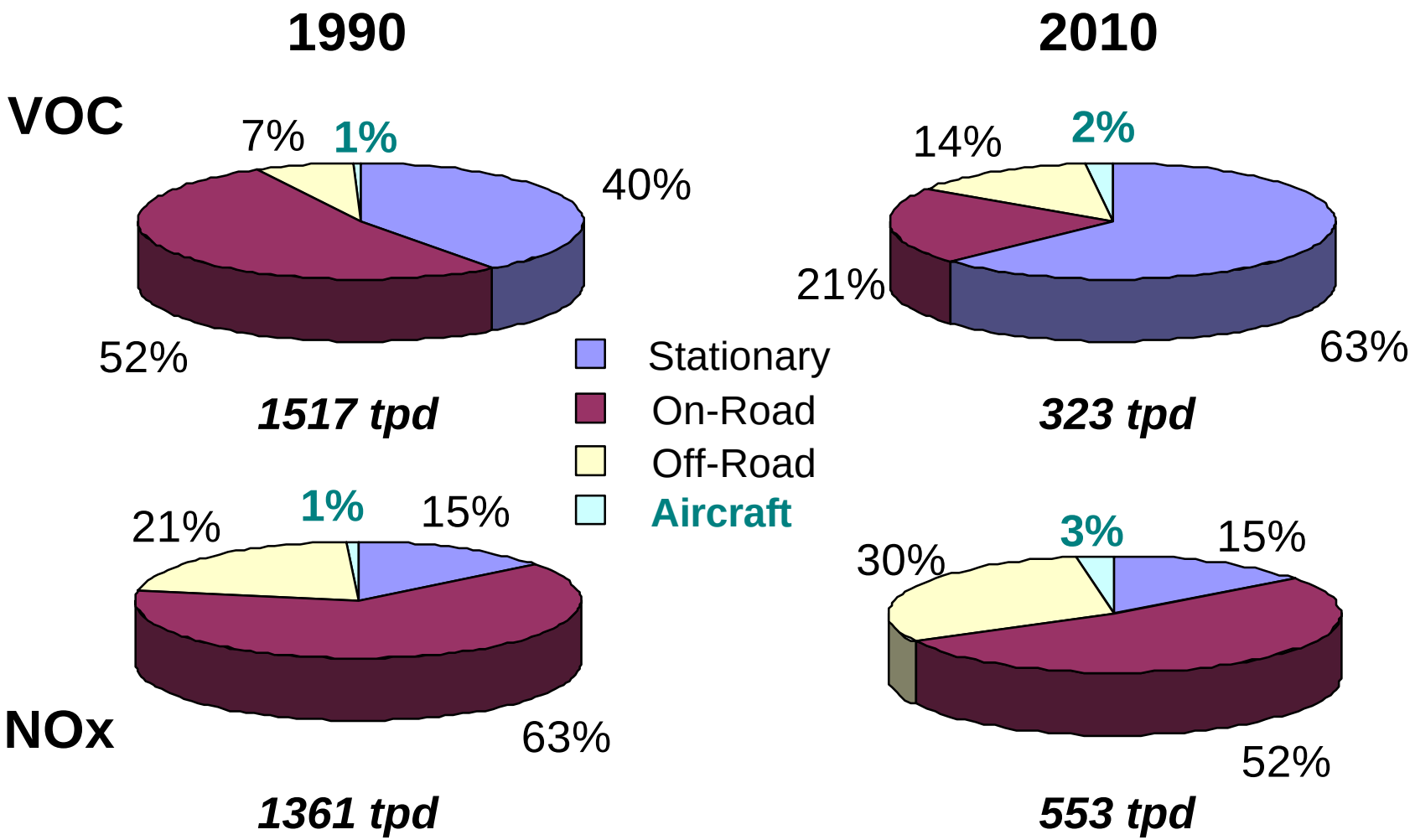
Air Travel Projections

Paul Helliker



SCAQMD Emissions

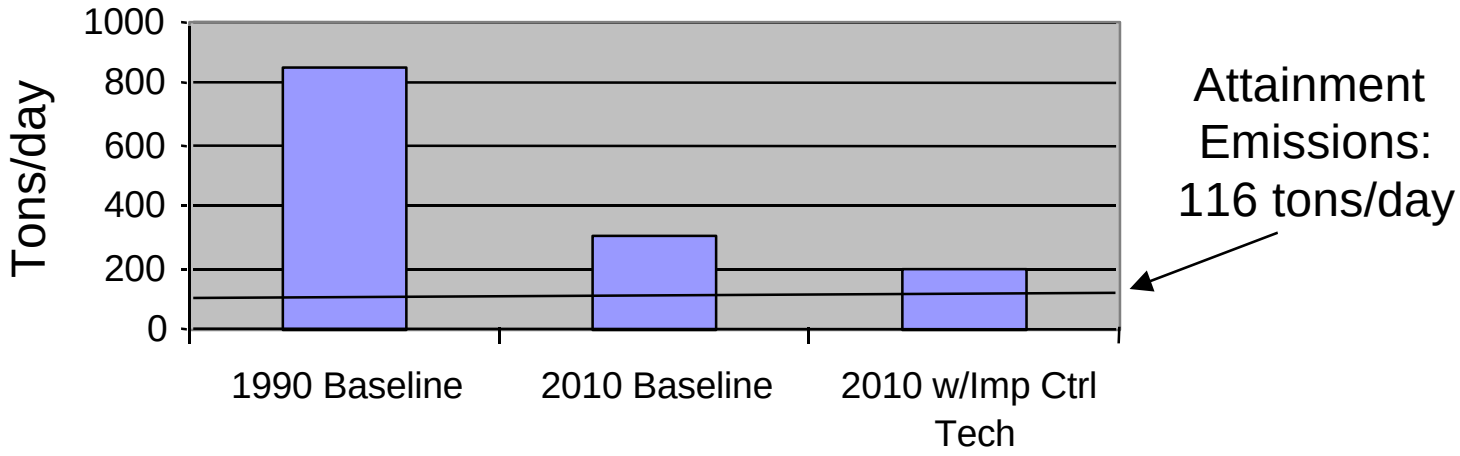
Paul Helliker



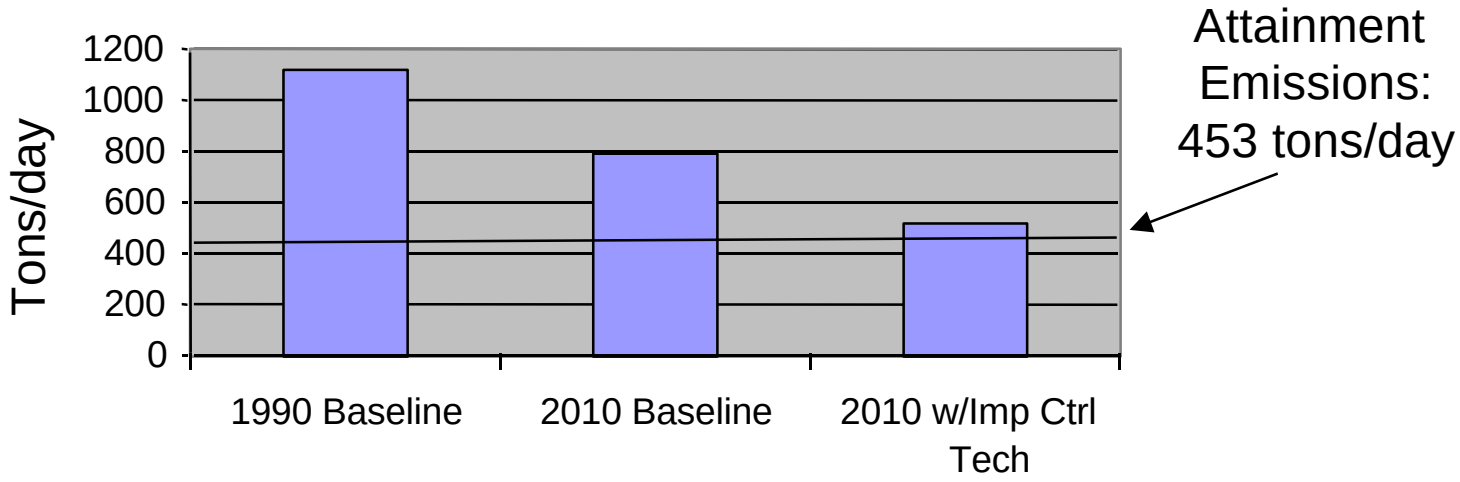
SCAB Mobile Sources

Paul Helliker

VOC



NOx



Emissions Comparison

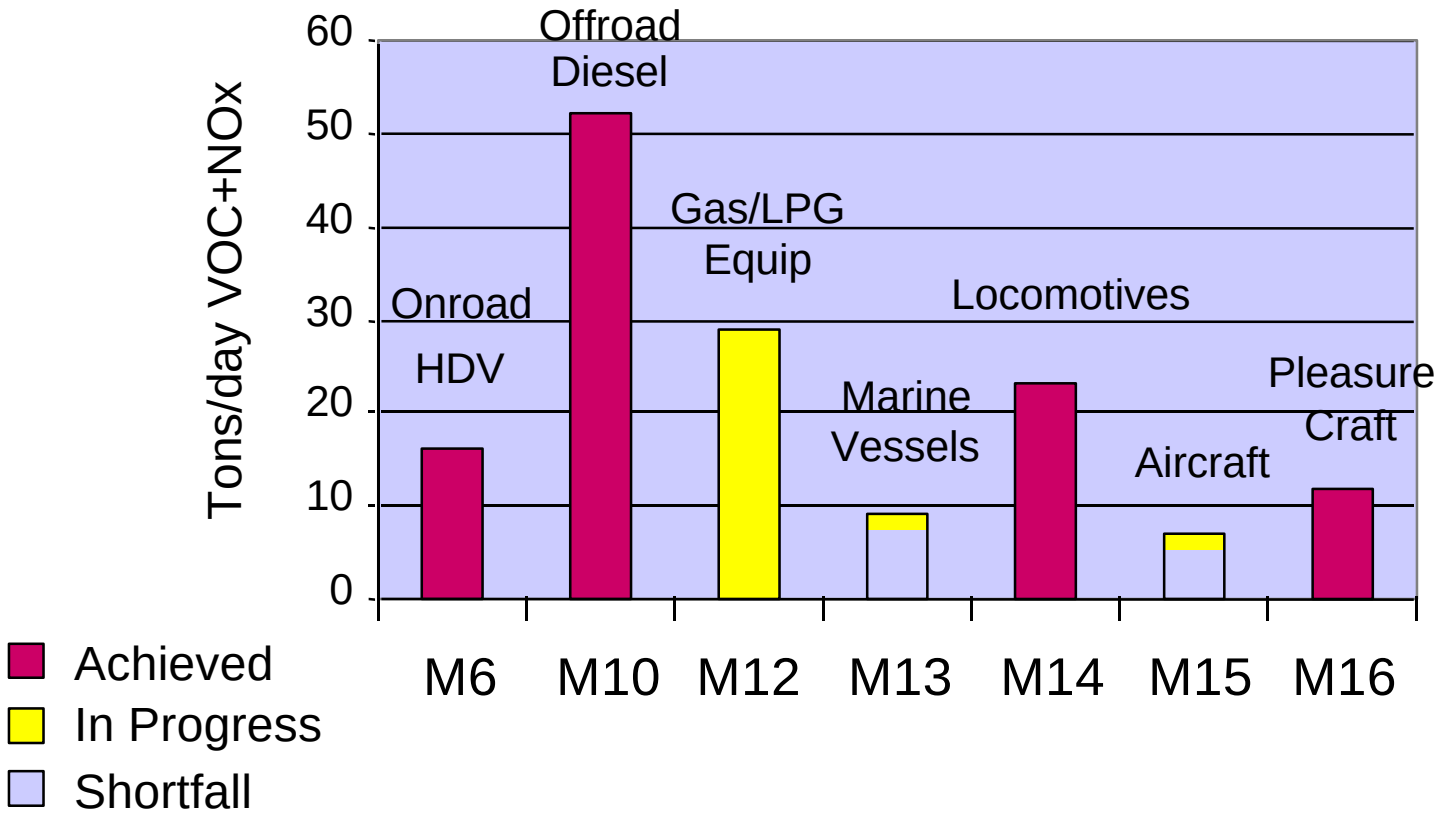
Paul Helliker

Rate (Tons/yr) and Ranking of Aircraft Emissions

	Rank in State for VOC	Emis-sions	Rank in State for NOx	Emis-sions
Chicago O'Hare	18	1,428	22	4,650
Salt Lake City	7	485	9	955
Bradley Inter'l	11	128	11	18

Federal Measures - 1994

Paul Helliker



New EPA Standards

Paul Helliker

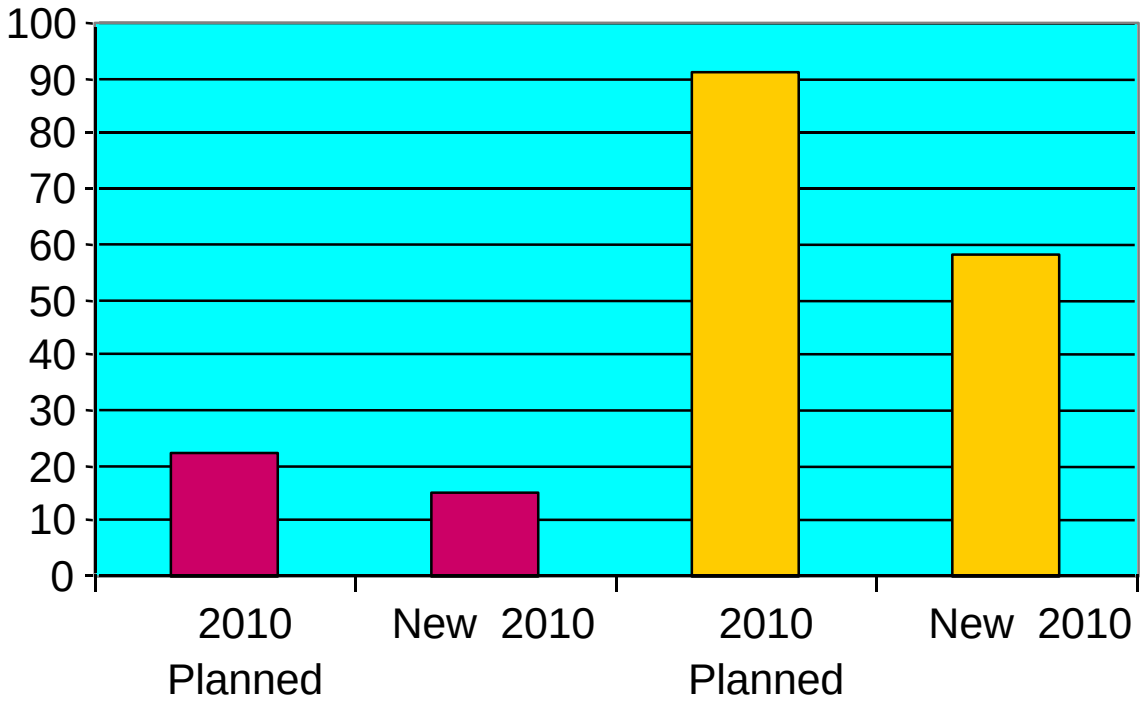
Preliminary Estimates of Additional Emissions Reductions Beyond 1997 SIP for PM 2.5 (in 2010) in SCAB:

- **NOx - 30% to 60%**
- **VOC - up to 35%**
- **NH3 - up to 100% (Dairies)**
- **SOx - up to 15%**
- **Primary - up to 10%**

Potential Control Requirements

Paul Helliker

Tons/day of Emissions from Aircraft, Locomotives and Marine Vessels

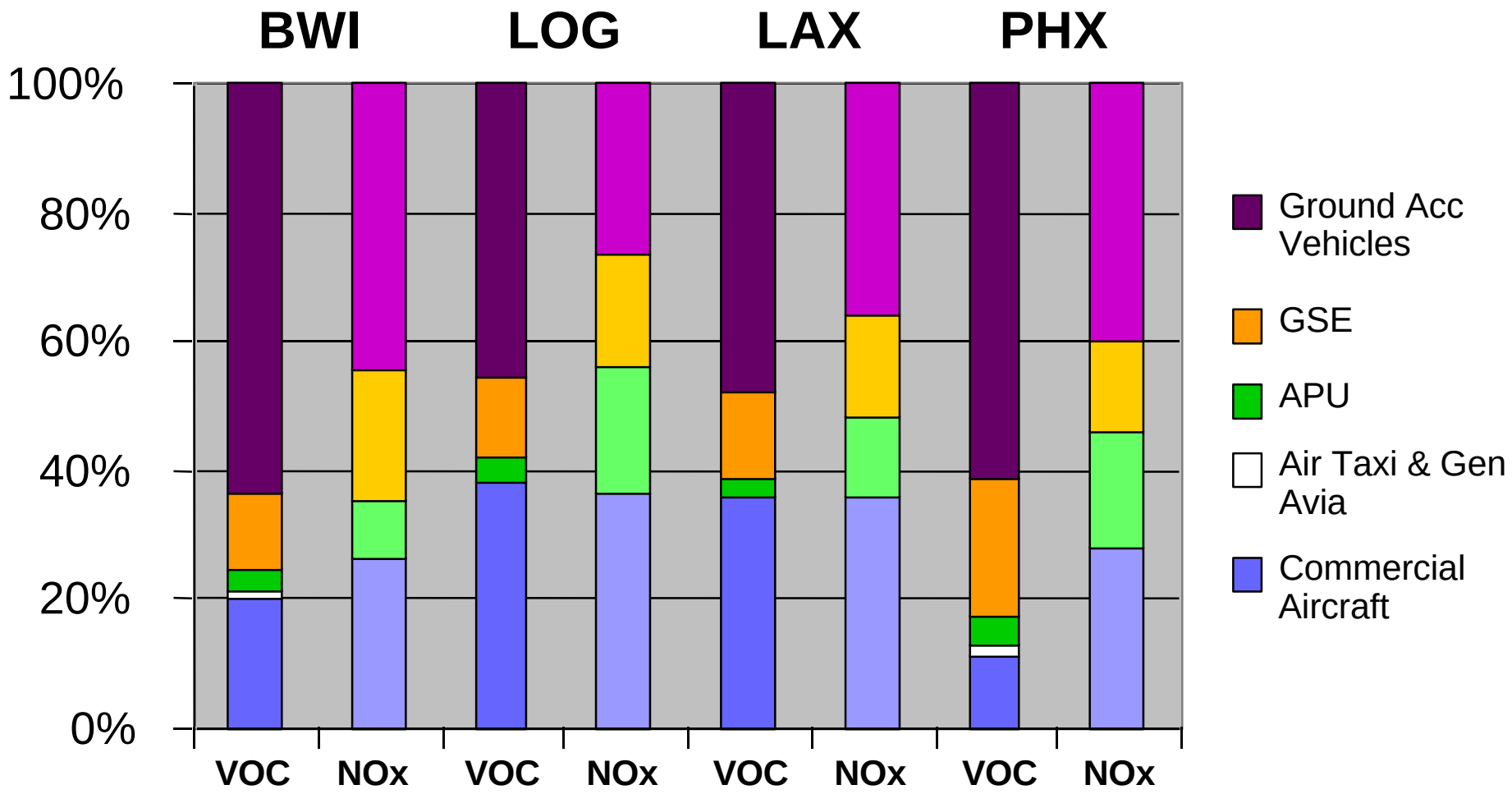


VOC -
32% reduction

NOx -
36% reduction

Emission Inventories

Paul Helliker



Paul Helliker

ICAO - International Civil Aviation Organization

- Originally created in 1944 to establish standard practices and procedures
- Adopted voluntary emission standards for aircraft in 1981 for CO and NOx
- Amended the emissions standards in 1993 - made NOx standard 20% more stringent

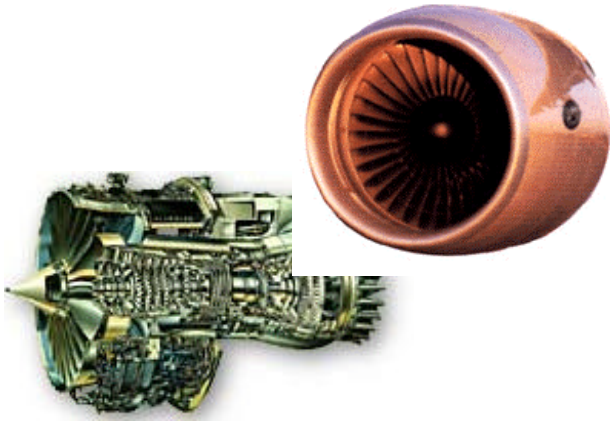
Paul Helliker

ICAO - International Civil Aviation Organization

- New NOx standard applies to new engines manufactured after Dec. 31, 1999
- Two engines don't comply:

  Pratt and Whitney JT8D-200

  Rolls-Royce RB211
- Both manufacturers are modifying combustion geometry and temperature to reduce NOx



Schiphol Airport

Paul Helliker

- **Operating guidelines for emissions from all sources**

- **For aircraft:**
  - **Traffic control measures**
  - **Taxiing on reduced engines**
  - **400 Hz power supply to reduce APU usage**

Schiphol Airport

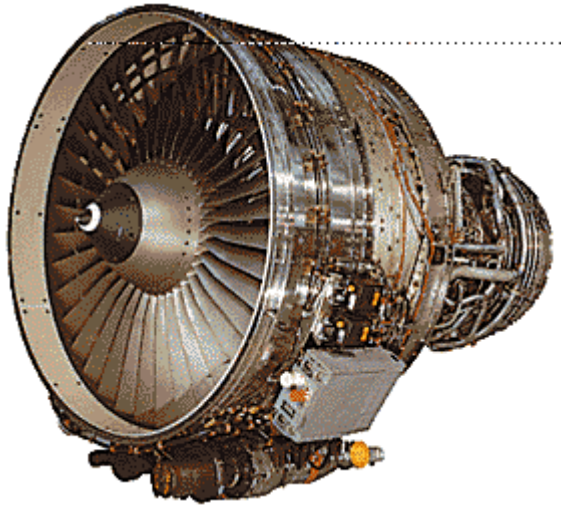
Paul Helliker

- **Developing alternative fuel program for airside vehicles**
- **Converted 77 light duty vehicles to CNG**
- **Promote public transit and bicycle use (high parking fees, excellent rail, bus and bike lane systems)**

CFMI Engines

Paul Helliker

- CFM International CFM 56-5B engine
- 22,000 - 32,000 lbs thrust
- Dual Annular Combustor Design
- In use on AB 320 and other short- and medium-range aircraft



Swissair/CFM

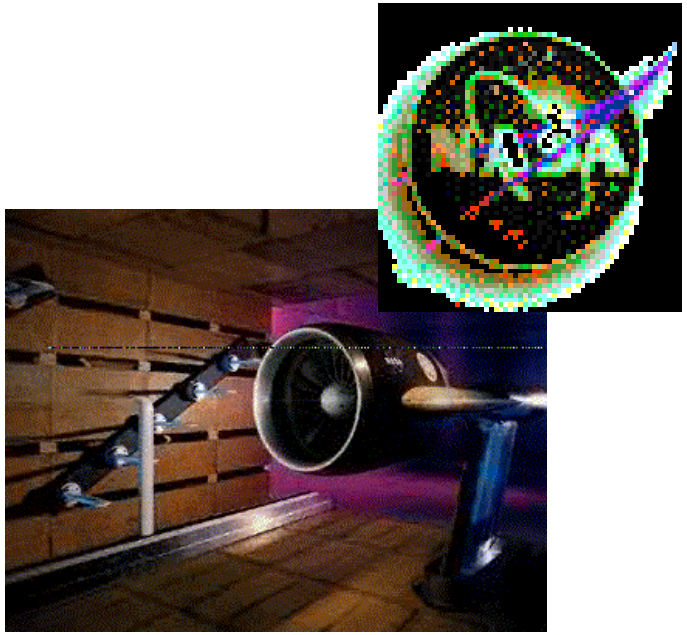
Paul Helliker

- **Low-NOx engine deployment program**
- **29 AB 320 aircraft in program - using CFM 56-5B engines**
- **Achieving NOx reductions of 35%**
- **Approximate 0.7% fuel consumption penalty**

NASA Research Efforts

Paul Helliker

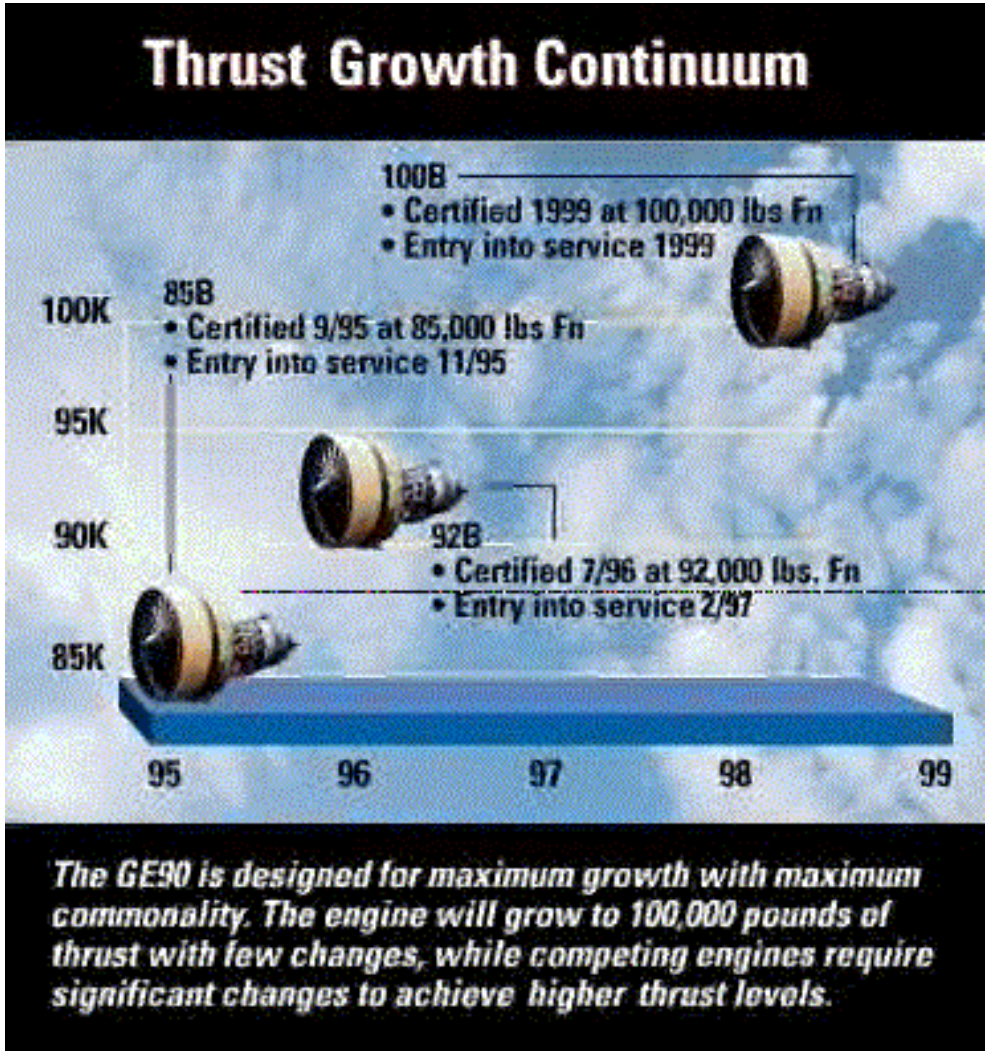
- **$500 million program**
- **Research goals: develop proof-of-concept engines that reduce NOx emissions by 50% by 1999 and 70% by 2001**
- **Fuel efficiency improvements of 8-10%**
- **Efforts include flametube, combustor sector and full annular combustor configuration testing**



GE 90 Engine Family

Paul Helliker

- Introduced in 1995 - typically used for B 777
- Dual combustor design
- Low NOx - 35% reduction from ICAO 1996 levels



Zurich Incentive Program

Paul Helliker

- **Swiss legislation requires NOx and HC emissions to be reduced to 1960 levels**
- **For airports, emissions fees were considered best method to incentivize emission reductions**
- **Engine emission factors were defined for all aircraft (NOx + VOC/thrust for typical LTO cycle)**
- **Five classes created - additional fees range from 5% to 40% of current landing fees)**

Zurich Incentive Program

Paul Helliker

- **Weight-based landing fees reduced - no net revenue to the airport**
- **Began October 1, 1997 - Currently being contested by ATA in court**
- **Weight-based fees range from $300 (B737) to $2,400 (B747)**
- **Cleanest engines include CFM-56 family (5), PW 4060/4460 (4)**
- **Program to expand to Geneva and Basle - Swedish also implementing similar program, starting January 1, 1998**

Reduced Engine Taxiing

Paul Helliker

Potential Emission Reductions at Newark International Airport, 1993

	VOC (tons/yr)	NOx (tons/yr)
Baseline Idle/ Taxi Emissions	857.53	295.88
"Delta Scenario," Idle/ Taxi Emissions	537.90	182.54
Added APU Emissions	0.36	9.66
Potential Net Reductions	318.27	103.68